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SCREENING OF CHILLI CULTIVARS AGAINST FUSARIUM WILT OF CHILLI (*CAPSICUM ANNUUM* L.)

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ABSTRACT

Evaluation of chilli cultivars/varieties against F. oxysporum causing wilt in chilli under in vitro conditions by water culture technique revealed that out of the twenty-two chilli cultivars/varieties, most of the cultivars/varieties were susceptible to the disease. Among the twenty-two cultivars screened, only one cultivar CO-4 showed resistant reaction (6.67% disease incidence), whereas, six cultivars viz., HC-1, GC-1, GC-2, Kashi Gaurav, Ajeet-6 and DKC-8 were moderately resistant with disease incidence of 15.56 to 24.44 per cent. Three cultivars viz., Pant C-1, Punjab Lal and Kashi Sinduri were moderately susceptible (33.33 to 48.99% DI) and remaining twelve cultivars/varieties were either susceptible (>50% DI) or highly susceptible (>75% DI). The cultivars Pusa Sadabahar and Arka Abhir were highly susceptible to wilt disease with 100 per cent disease incidence.

KEYWORDS: Capsicum annuum, Fusarium oxysporum, Cultivars, Screening, Resistant & Disease Incidence

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INTRODUCTION

Chilli (*Capsicum annuum* L.) is one of the most important spice and vegetable crop cultivated throughout the world. India is the leading producer and consumer of chilli with production of 14.92 lakh tonnes from 7.74 lakh hectare and the productivity is 1.92 MT/ha (Anonymous, 2014). A number of biotic and abiotic factors are a constraint in chilli production. The fungi, bacteria and viruses as biotic agent have drastically reduced the yield potential and the quality (Ochoa and Ramirez, 2001; Egea *et al*., 2002). Fusarium wilt of chilli has emerged as a serious problem in past decade with the disease incidence of 2-85 per cent in different regions of India (Anonymous, 2005). *Fusarium oxysporum* and *F. solani* are reported as the most common species of *Fusarium* found associated with wilt of chilli in India, whereas, *F. moniliforme* and *F. pallidoroseum* as causal agents are found in some parts of India (Naik, 2006). The yield losses due to the disease is known to vary from 10-80 per cent worldwide (Loganathan *et al*., 2013) depending upon the variety being grown and prevailing climatic conditions. The pathogen is necrotrophic, typically soil-borne (Booth, 1971). Generally, the dry weather condition and excessive soil moisture enhance the disease development. The characteristic symptoms of the disease are brown vascular discoloration followed by upward and inward rolling of the upper leaves and subsequently wilting of the plant (MacHardy and Beckman, 1981; Rivelli, 1989). Among the different available options for the management, chemicals are neither economically viable, nor safe for the environment. The best way of management of this disease is only use of resistant cultivars. So, the availability of genetic diversity of *Capsicum* species in both wild and domesticated ecosystem and screening of these elite pepper germplasms/ cultivars resistant to pathogen is the most effective control strategy against the disease (Kelaiya and Parakhia, 2000;

Candole *et al*., 2010; Joshi *et al*., 2012; Shafique *et al*., 2015). Therefore, a large scale screening of the promising chilli germplasm/cultivars is needed as a source of resistance for developing resistant lines/hybrids of chilli against the wilt pathogen.

MATERIALS AND METHODS

Screening of germplasm/cultivars for relative resistance/tolerance against Fusarium wilt was carried out *in vitro* through water culture technique as per method described by Nene and Kannaiyan (1982) and Haware and Nene (1994) at Department of Plant Pathology, CCS HAU, Hisar. Evaluation of resistance in the cultivars/varieties was measured based on their survival in water culture technique inoculated with the pathogen. The experiment was laid under completely randomized design (CRD) with three replicates of each cultivar, arranged with fifteen plants per replication. The seedlings of the chilli cultivars/varieties were raised in plastic pots filled with sterilized riverbed sand. Three-four weeks old seedlings were pulled out gently and the roots were washed under running tap water. These seedlings were transferred to test tubes containing 20 ml of inoculums suspension of *F. oxysporum* (as virulent one) with spore density of $1x10^6$ conidia/ml suspension. For preparing the inoculums suspension, the pure culture of *Fusarium* isolates were multiplied on 100 ml of potato dextrose broth (PDB) in 250 ml flasks that were incubated at 27±1°C in BOD incubator with rotary shaker under alternate 12 hrs light and night for 15 days. The inoculated medium (PDB) was poured through cheese clothes to separate spores from mycelia. The spore density in the suspension was determined with haemocytometer and the required spore density (*i.e.*, $1x10^6$ conidia/ml suspension) was maintained with sterile distilled water. An un-inoculated seedling set containing sterile distilled water was kept as a check. Sterile distilled water was added to the tubes every 48 hrs to make up for any loss of water. The test tubes with seedling were placed in incubator at 27±1°C under alternate 12 hrs of light and dark conditions for four weeks for development of the symptoms. The disease incidence in different genotypes/ cultivars was recorded and the per cent disease incidence was calculated as per the formula mentioned below.

$$\text{Wilt Incidence (\%)} = \frac{\text{Number of wilted plants}}{\text{Total number of plants}} \times 100$$

After recording the disease incidence, the cultivars/varieties were grouped under different reaction categories according to 0-5 rating scale of Devika Rani *et al*. (2008). The disease reaction groups were immune (I), resistant (R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) with 0, 1-10, 11-25, 26-50, 51-75 and 76- 100 per cent disease incidence, respectively. The data was analysed by OPSTAT package of programs (Sheoran, 2006) after arcsine transformation.

RESULTS

Twenty-two chilli cultivars/varieties evaluated against *F. oxysporum* (*i.e*., Isolate Fo8) showed that most of the cultivars/varieties were susceptible to the fungus and few exhibited resistant or moderately resistant reaction. The plants inoculated through water culture technique started wilting in seven to tenth days of inoculation, which continued up to 2-3 weeks. Among twenty-two cultivars screened for resistance against *F. oxysporum*, none was found fully resistant/immune, however, cultivar CO-4 showed resistant reaction (6.67% wilt). Six cultivars *viz*., HC-1, GC-1, GC-2, Kashi Gaurav, Ajeet-6 and DKC-8 were moderately resistant having the disease incidence varied from 15.56 to 24.44 per cent, whereas,

three cultivars *viz*., Pant C-1, Punjab Lal, Kashi Sinduri were moderately susceptible (33.33 to 48.99% wilt). The remaining twelve cultivars were either susceptible (>50% wilt) or highly susceptible (>75% wilt). The cultivars Pusa Sadabahar and Arka Abhir were highly susceptible to wilt disease (100 %) (Table 1, Figure 1). The cultivars/varieties were further categorized into five groups based on the disease reaction as presented in Table 2.

Table 1: Screening of different Chilli Cultivars to *F. oxysporum* for Resistance against Fusarium Wilt

Sr. No.	Cultivars/ Varieties	Temporal Wilt Incidence (%)			Reaction
		1st Wk	2nd Wk	3rd Wk	
1	Pusa Jwala	64.44	73.33	73.33	S
2	Arka Meghana	68.89	80.00	84.44	HS
3	California Wonder	51.11	68.89	68.89	S
4	Pant C-1	26.67	33.33	33.33	MS
5	Pusa Sadabahar	86.67	100.00	100.00	HS
6	HC-1	24.44	24.44	24.44	MR
7	HC-2	44.44	57.78	57.78	S
8	Arka Lohit	55.56	68.89	73.33	S
9	Punjab Lal	48.89	48.89	48.89	MS
10	GC-1	15.56	17.78	17.78	MR
11	GC-2	13.33	15.56	15.56	MR
12	GAVC-111	57.78	84.44	84.44	HS
13	GAVC-112	75.56	75.56	75.56	HS
14	CO-4	6.67	6.67	6.67	R
15	Kashi Gaurav	17.78	20.00	20.00	MR
16	Kashi Sinduri	31.11	42.22	46.67	MS
17	G-4	82.22	91.11	91.11	HS
18	Arka Abhir	100.00	100.00	100.00	HS
19	Kashi Anmol	64.44	71.11	71.11	S
20	Kalyanpur Chanchal	77.78	86.67	86.67	HS
21	Ajeet-6	22.22	24.44	24.44	MR
22	DKC-8	15.56	22.22	22.22	MR

R- Resistant, MR- Moderately resistant, MS- Moderately susceptible, S- Susceptible, HS- Highly susceptible; (0-5 rating scale by Devica Rani *et al*., 2008).

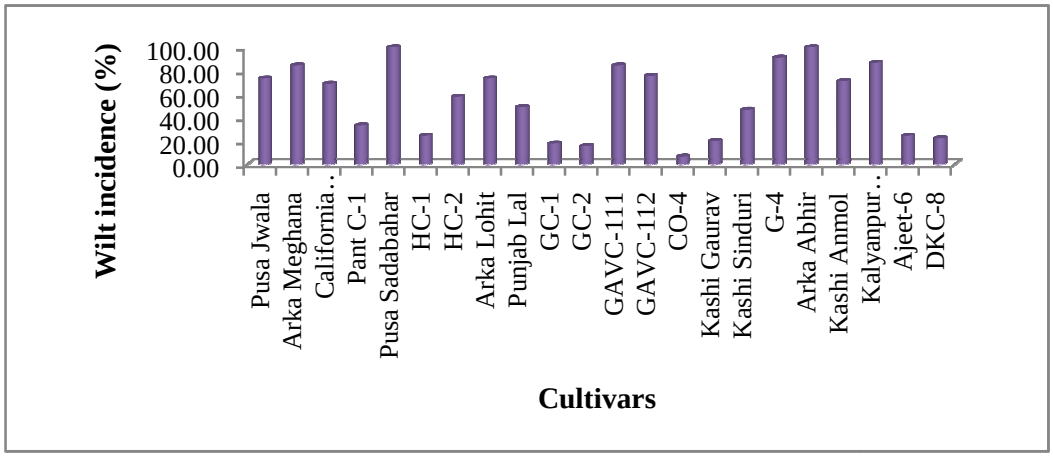

Figure 1: Screening of Different Chilli Cultivars against Fusarium Wilt Caused by *F. oxysporum*

Table 2: Grouping of Chilli Cultivars for Resistance Against Fusarium Wilt Incited by *F. oxysporum*

Infection (%)	Reactions of Different Chilli Cultivars/Varieties against *F. oxysporum*	
	Reaction†	Cultivars
0	Immune (I)	Nil
1-10	Resistant (R)	CO-4
11-25	Moderately resistant (MR)	HC-1, GC-1, GC-2, Kashi Gaurav, Ajeet-6, DKC-8
26-50	Moderately susceptible (MS)	Pant C-1, Punjab Lal, Kashi Sinduri
51-75	Susceptible (S)	Pusa Jwala, California Wonder, HC-2, Arka Lohit, Kashi Anmol
76-100	Highly susceptible (HS)	Arka Meghana, Pusa Sadabahar, GAVC-111, GAVC-112, G-4, Kalyanpur Chanchal, Arka Abhir

† Category of resistance/susceptibity of chilli genotypes/cultivars (0-5 rating scale by Devica Rani *et al*., 2008).

DISCUSSIONS

Identification of diverse and stable field source resistance to Fusarium wilt is imperative and pre-requisite to a resistance breeding programme. The use of resistant variety is beneficial not only in reducing the losses due to diseases but these sources are also useful to minimize the fungicidal toxicity (Parey *et al*., 2013; Manu *et al*., 2014). In the present investigation, twenty-two cultivars were screened for resistance against *F. oxysporum*, the cultivar CO-4 showed resistant reaction (6.67% wilt), however, six cultivars *viz*., HC-1, GC-1, GC-2, Kashi Gaurav, Ajeet-6 and DKC-8 were moderately resistant (15.56 to 24.44% wilt), whereas, three cultivars *viz*., Pant C-1, Punjab Lal, Kashi Sinduri were moderately susceptible (33.33 to 48.99% wilt) and the remaining twelve cultivars were either susceptible (>50% wilt) or highly susceptible (>75% wilt), which could not survive against the pathogen. The results of present study coincide with the previous work done by Kelaiya and Parakhia (2000) who have reported that the chilli cultivars *viz*., GC-1 and GC-2 were resistant, whereas, Pusa Jwala and HC-1 were moderately resistant against the *Fusarium solani*. The present studies are also in conformity with Devika Rani *et al*. (2008) who reported the chilli cv. Pant C-1 and Ajeet-6 were moderately resistant, whereas, Pusa Jwala, Pusa Sadabahar, Arka Meghana and Arka Abhir as susceptible to highly susceptible to *Fusarium solani* under rapid-root-dip transplanting technique. In the present study, the cultivar CO-4 was found resistant (6.67% wilt incidence) and the similar observation was recorded by Joshi *et al.* (2012) who reported this variety to be resistant against the disease. The results are also supported by different workers with varying degree of resistance depending upon the method of inoculation and the location (Ahmed *et al*., 1994; Nayeema *et al*., 1995; Kelaiya and Parakhia, 2000; Devika Rani *et al*., 2008; Naik *et al*., 2008; Joshi *et al.*, 2012; Maruti *et al*., 2014; Shafique *et al*., 2015).

The resistance of the cultivar CO-4 (resistant) and other moderately resistant cultivars may be attributed to their genetic background with higher metabolic/gene activity unsuitable to the Fusarium wilt pathogen. The reason for this might be the antifungal compounds such as phenolics produced by resistant lines/cultivars was more potent than other compounds, especially those produced by susceptible lines/cultivars (Iftikhar *et al*., 2005; Jamil *et al*., 1996; Sahi *et al*., 2000). In addition to environmental conditions, amount of inocula, types of phytoalexins and the genetic structure of a plant also affect the resistance of plants against the pathogen. The longer incubation period of the resistant and moderately resistant accessions/cultivars compared to the susceptible ones might be responsible for either delaying the initial infection of the disease or slow down of the rate of wilting.

CONCLUSIONS

These identified germplasm/cultivars could be used in hybridization programmes to develop cultivars possessing desirable traits besides resistance to Fusarium wilt pathogen. Even in chilli wilt, there is an equal opportunity to utilize the

wilt resistant donor sources in the background of popular cultivars to improve the wilt resistance during resistance breeding programme. The highly susceptible cultivars can be used as infector rows and the cultivars showing resistant to moderately resistant reaction can be used as donor for resistance in further resistant breeding programmes. However, it would be too much to expect stable resistance against *Fusarium* diseases because of high variability and dynamic nature of the pathogen (Devika Rani *et al*., 2008). The inheritance of *Fusarium* wilt resistance in chilli has been of monogenic dominant in nature; hence, heterosis breeding using the resistant source is advocated to boost the yield potential of the crop and to avoid the use of pesticides in reducing the environmental pollution (Manu *et al*., 2014).

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